

AMENDMENTS TO THE SPECIFICATION:

Page 1, please add the following new paragraphs before paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/DE 2004/000413
filed on March 4, 2004.

[0000.6] BACKGROUND OF THE INVENTION

Please add the following new paragraph after paragraph [0001]:

[0001.2] This invention relates to an improved fuel injection system for injecting fuel into
internal combustion engines.

Please add the following new paragraph after paragraph [0001.2]:

[0001.4] Description of the Prior Art

Please replace paragraph [0002] with the following amended paragraph:

[0002] ~~For introducing fuel into direct-injection internal combustion engines, stroke-~~
~~controlled~~ **Stroke-controlled** injection systems with a high-pressure reservoir (common rail)
for introducing fuel into direct-injection internal combustion engines are used ~~used~~ **known**.

The advantage of these injection systems is that the injection pressure can be adapted over
wide ranges to the load and rpm. To reduce emissions and to attain high specific output, a
high injection pressure is necessary. The attainable pressure level of high-pressure fuel
pumps is limited for reasons of strength, so that to further increase the pressure in fuel
injection systems, pressure boosters are used in the fuel injectors.

Please delete paragraph [0003].

Please replace paragraph [0004] with the following amended paragraph:

[0004] German Patent Disclosure DE 101 23 913 ~~has~~ discloses a fuel injection system for internal combustion engines, with a fuel injector that can be supplied from a high-pressure fuel source~~[[,]] as its subject~~. Connected between the fuel injector and the high-pressure fuel source is a pressure booster device that has a movable pressure booster piston. The pressure booster piston divides a chamber that can be connected to the high-pressure fuel source from a high-pressure chamber that communicates with the fuel injector. By filling a differential pressure chamber of the pressure booster device with fuel, or evacuating the differential pressure chamber of fuel, the fuel pressure in the high-pressure chamber can be varied. The fuel injector has a movable closing piston for opening and closing injection openings. The closing piston protrudes into a closing pressure chamber, so that the closing piston can be subjected to fuel pressure to attain a force acting in the closing direction ~~on the closing piston~~. The closing pressure chamber and the differential pressure chamber are formed by a common closing pressure differential pressure chamber; all the subsidiary regions in the closing pressure differential pressure chamber communicate with one another permanently for exchanging fuel. A pressure chamber is provided for supplying the injection openings with fuel and subjecting the closing piston to a force acting in the opening direction. A high-pressure chamber communicates with the high-pressure fuel source in such a way that in the high-pressure chamber, aside from pressure fluctuations, at least the fuel pressure of the high-pressure fuel source can always be applied; the pressure chamber and the high-pressure chamber are formed by a common injection chamber. All the subsidiary regions of the injection chamber communicate permanently with one another for exchanging fuel.

Page 3, please replace paragraph [0007] with the following amended paragraph:

[0007] Summary of the Invention

SUMMARY OF THE INVENTION

Page 4, please replace paragraph [0011] with the following amended paragraph:

[0011] ~~Drawing~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Please replace paragraph [0012] with the following amended paragraph:

[0012] The invention will be described in further detail below, in conjunction with the
~~drawing:~~ **drawings, in which:**

Please delete paragraph [0013].

Please replace paragraph [0014] with the following amended paragraph:

[0014] Fig. 1[[,]] **is a schematic view, in section, of** a first ~~variant~~ embodiment of a servo valve, embodied as a 3/2-way valve, with a servo valve piston free of guidance leakage;

Please replace paragraph [0015] with the following amended paragraph:

[0015] Fig. 2[[,]] **is a similar view of** a further ~~variant~~ embodiment of a servo valve piston of a 3/2-way servo valve with a first seat embodied as a conical sealing seat and a further seat embodied as a slide seal;

Please replace paragraph [0016] with the following amended paragraph:

[0016] Fig. 3[[,]] **is a similar view of an** ~~a-variant~~ embodiment of a 3/2-way servo valve with a servo valve piston on which a control sleeve is received; and

Please replace paragraph [0017] with the following amended paragraph:

[0017] Fig. 4[.,]] ~~is an a variant~~ embodiment of a 3/2-way servo valve with an elongated servo valve piston.

Page 5, please replace paragraph [0018] with the following amended paragraph:

[0018] Variant Embodiments

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Please delete paragraph [0019].

Please replace paragraph [0020] with the following amended paragraph:

[0020] **In Fig. 1, a first variant embodiment of a 3/2-way servo valve proposed according to the invention, for triggering a fuel injector that contains a pressure booster, can be seen.** Via a pressure source 1 and a high-pressure supply line 2 connected to it, a work chamber 5 of a pressure booster 3 is subjected to fuel that is at high pressure. The work chamber 5 is subjected permanently to the fuel, at high pressure, of the pressure source 1. The pressure booster 3 includes a one-piece booster piston 4, which separates the work chamber 5 from a differential pressure chamber 6. The booster piston 4 is subjected to a restoring spring 8, which is braced on one end on a support disk 7 and on the other on a stop disk mounted on a protrusion of the booster piston 4. The **differential pressure chamber 6** ~~of~~ pressure booster 3 ~~moreover includes a compression chamber 9, which~~ communicates via an overflow line 10 with a control chamber 12 for an injection valve member 14. A first throttle restriction 11 is received in the overflow line 10 from the differential pressure chamber 6 to the control chamber 12 for the injection valve member 14.

Please replace paragraph [0021] with the following amended paragraph:

[0021] A spring element 13 is received in the control chamber 12 for the injection valve member 14 and acts upon one face end of the needle-like injection valve member 14. The injection valve member 14 includes a pressure step, which is surrounded by a pressure chamber 16. The pressure chamber 16 is subjected to fuel that is at boosted pressure via a pressure chamber inlet 17 that branches off from the compression chamber 9 of the pressure booster 3. From the differential pressure chamber 6 of the pressure booster 3, a diversion line 21 extends into the first housing part 26 of ~~the~~ a servo valve housing 25. The end face of the booster piston that acts upon ~~the~~ a compression chamber 9 of the pressure booster 3 is identified by reference numeral 20. Because of the pressure step at the injection valve member 14, the injection valve member executes an opening motion when the pressure chamber 16 is acted upon by **boosted** pressure, so that from the pressure chamber 16, fuel flows ~~to injection openings 22~~ along an annular gap **to injection openings 22** and reaches a combustion chamber 23 of a self-igniting internal combustion engine.

Page 6, please replace paragraph [0023] with the following amended paragraph:

[0023] Above the injector body 19 of a fuel injector 18, there is a servo valve housing 25, which receives a servo valve 24. In the ~~variant~~ embodiment shown in Fig. 1, the servo valve housing 25 is embodied in two parts and includes a first housing part 26 and a second housing part 27. The two-part embodiment of the servo valve housing 25 in the shown in Fig. 1 allows good accessibility for machining the sealing seat and a slide edge, making the servo valve 24 simple and economical to produce.

Please replace paragraph [0024] with the following amended paragraph:

[0024] From the high-pressure supply line 2, by way of which the work chamber 5 of the pressure booster 3 is subjected to fuel that is at high pressure, a supply line 29 branches off into the valve housing 25. The supply line 29 discharges into a first hydraulic chamber 38 of the first housing part 26 of the servo valve housing 25. The first hydraulic chamber 38 surrounds a servo valve piston 32, which includes a through conduit 33. A third throttle restriction 34 is embodied in the through conduit 33 of the servo valve piston 32. Via the through conduit 33[[,] **and throttle 34**, fuel flows from the first hydraulic chamber 38 into a control chamber 36 of the servo valve 24. A pressure relief of the control chamber 36 is effected upon actuation of a switching valve 30, upon whose opening, control volume from the control chamber 36, via a return that contains an outlet throttle restriction 37 (fourth throttle restriction), communicates with a further low-pressure-side return 31, and fuel can be diverted into this return. The control chamber 36 of the servo valve 24 is defined by an end face 35 on the top side of the servo valve piston 32. This control chamber is located at the head of the servo valve piston 32, opposite an annular face which is operative in the opening direction of the servo valve piston 32 and is acted upon by the pressure prevailing in the first hydraulic chamber 38. Also embodied on the servo valve piston 32 are a first sealing seat 40, in a second hydraulic chamber 39, and a control edge 41. Via the first sealing seat 40, the communication with an outlet control chamber 42, from which a low-pressure-side return 28 branches off, is opened and closed. By means of the control edge 41, which in the **variant** embodiment shown in Fig. 1 for the servo valve 24 is embodied as a slide sealing edge 43, the first hydraulic chamber 38, which is at system pressure, is sealed off from the second

hydraulic chamber 39 while the servo valve piston 32 is moving in the vertical direction. The two returns 28, 31 on the low-pressure side are if at all possible combined into one return, which discharges into a fuel tank.

Page 7, please replace paragraph [0025] with the following amended paragraph:

[0025] To reinforce the motion of the servo valve piston 32 in the first housing part 26, spring forces - although not shown in Fig. 1 - can be brought to bear on the servo valve piston 32 ~~via springs. A first variant~~ **The** embodiment of the servo valve 24 shown in Fig. 1 makes an extremely compact construction of the servo valve 24 possible. In the view in Fig. 1, the first sealing seat 40 of the servo valve 24 is embodied as a flat seat, but it could also be embodied as a conical seat (as shown in Fig. 2), a ball seat, or a slide edge. Advantageously, embodying the first sealing seat 40 as a flat seat makes it possible to use a valve body 25 constructed in multiple parts. By means of the first sealing seat 40 embodied as a flat seat, any axial offsets that might occur as a result of production variations can be compensated for without problems. Moreover, by means of the closing force on the flat seat of the first sealing seat 40, brought to bear in the control chamber 36 of the servo valve 24, a very high pressure per unit of surface area and hence good sealing are attained. The first sealing seat 40 may be embodied as either a sealing edge or a sealing face. The sealing force can be adjusted via the pressure face opposite the outlet control chamber 42. As a result, when a sealing face is used, optimal design of the pressure per unit of surface area is possible, as a result of which both adequate tightness on the one hand and only slight wear on the other can be achieved.

Page 8, please delete paragraph [0026].

Please replace paragraph [0027] with the following amended paragraph:

[0027] **Fig. 2 shows a further variant embodiment of the servo valve proposed according to the invention, in which its first sealing seat is embodied as a conical sealing seat.** ~~The view in~~ Fig. 2 also shows a fuel injector 18 which contains a pressure booster 3. The work chamber 5 of the pressure booster 3 is supplied with fuel that is at high pressure via a pressure source 1 (common rail) via the high-pressure supply line 2. In a distinction from the embodiment of the pressure booster 3 in the variant embodiment of Fig. 1, the booster piston 4 of the pressure booster 3 as shown in Fig. 2 is embodied in multiple parts. A support disk 7 is let into the injector body 19 of the fuel injector 18 and represents an upper stop face for the upper part of the multi-part booster piston 4. The lower part of the booster piston 4 is acted upon by a restoring spring 8 that is braced on the housing 19; the compression chamber 9 of the pressure booster 3 is defined by way of the end face 20 of the lower part of the booster piston 4. From the differential pressure chamber 6 of the pressure booster 3, an overflow line 10 which contains the first throttle restriction 11 branches off. The overflow line 10 connects the differential pressure chamber 6 of the pressure booster 3 to the control chamber 12 for controlling the reciprocating motion of the injection valve member 14, which is embodied in the form of a needle. The pressure chamber inlet 17 extends from the compression chamber 9 of the pressure booster 3 and discharges into the pressure chamber 16 surrounding the injection valve member 14. The injection valve member 14 includes a pressure step, which has a hydraulically operative face[.] ~~The latter is~~ engaged by the fuel pressure prevailing in the pressure chamber 16, which opens the injection valve member 14,

so that fuel is injected via injection openings 22, which discharge into the combustion chamber of the self-igniting internal combustion engine and which are opened upon opening of the injection valve member 14.

Please replace paragraph [0028] with the following amended paragraph:

[0028] In a distinction from the variant embodiment shown in Fig. 1, a damping piston 51 is received in the control chamber 12 for the injection valve member 14. The damping piston 51 is penetrated by a vertically extending conduit 53. The conduit 53 communicates hydraulically with the control chamber 12, via a fifth throttle restriction 52 in the wall of the damping piston 51. An annular ~~face~~ flange 55 embodied on the damping piston 51 is acted upon by a spring element 54 braced on the housing. From the control chamber 12 for the injection valve member 14, a filling line 56, which contains a refill valve 50 that may be embodied as a check valve, extends to the compression chamber 9 of the pressure booster 3. Via the filling line 56 that contains the refill valve 50, the compression chamber 9 of the pressure booster 3 is refilled with fuel.

Page 9, please replace paragraph [0029] with the following amended paragraph:

[0029] In the variant embodiment shown in Fig. 2, the servo valve 24 is received in the valve body 25. The servo valve 24 includes the control chamber 36, which can be pressure-relieved into the second low-pressure-side return 31 via the switching valve 30. An outlet throttle 37 (fourth throttle restriction) is received between the control chamber 36 and the switching valve 30. ~~Diametrically opposite~~ Opposite the control chamber 36 in the valve body 25 of the servo valve 24 is the first hydraulic chamber 38, which is separated by the

control edge 41 from the second hydraulic chamber 39, in this case configured conically. The second hydraulic chamber 39 communicates with the differential pressure chamber 6 of the pressure booster 3. In the variant embodiment of the servo valve 24 in Fig. 2 as well, the control edge 41 is embodied as a slide sealing edge 43. Unlike the variant embodiment of the servo valve 24 shown in Fig. 1, the first sealing seat 40 of the servo valve piston 32 is embodied as a conical seat. When the first sealing seat 40 is closed, the outlet control chamber 42 embodied in the valve body 25 below the servo valve piston 32 is sealed off, so that the first low- pressure-side return 28 is closed.

Page 13, please replace paragraph [0040] with the following amended paragraph:

[0040] The first sealing seat 40 may be embodied as a flat seat, which makes a high pressure per unit of surface area possible, or a conical seat (as shown in Fig. 2), as a ball seat, or as a slide edge. Via the flat seat shown in Fig. 1 as the first sealing seat 40, any axial offset that may occur for production reasons can be compensated for. By way of the high pressure level prevailing in the control chamber 36, the generation of a sufficient closing force is accomplished, so that a **high** pressure per unit of surface area occurs at the first sealing seat 40 in its closing position, and good sealing action thus remains assured.

Page 14, please delete paragraph [0043].

Please replace paragraph [0044] with the following amended paragraph:

[0044] **From Fig. 3, a variant embodiment can be seen of a 3/2-way servo valve having a servo valve piston on which a control sleeve is received.** The variant embodiment shown

~~in Fig. 3 of a fuel injector 18 with a~~ pressure booster 3 is supplied with fuel, which is at high pressure, via a high-pressure source 1 via the high-pressure supply line 2. The work chamber 5 of the pressure booster 3 is filled with system pressure via the high-pressure supply line 2, and received in the work chamber is a restoring spring 8, which is braced on one side on a support disk 7 and on the other side is prestressed via a stop face of the booster piston 4 that separates the work chamber 5 from the differential pressure chamber 6. The face end 20 of the booster piston 4 defines the compression chamber 9, from which, upon activation of the pressure booster 3, the pressure chamber 16 is filled with fuel that is at high pressure, via the pressure chamber inlet 17.

Page 15, please replace paragraph [0047] with the following amended paragraph:

[0047] The servo valve 24 includes a housing 25 that includes a plurality of housing parts 26, **27, and 66.**

Please replace paragraph [0049] with the following amended paragraph:

[0049] The servo valve piston 32 furthermore includes the hydraulic face 44, which is engaged, upon pressure relief of the control chamber 36 of the servo valve 24, by a pressure force that moves the servo valve piston 32 in the opening direction. First recesses 63, which have slide sealing edges 43, are embodied in the servo valve piston portion 65. The slide sealing edges 43 of the first recesses 63 cooperate with a control edge 41 embodied on the second housing part 27. A control sleeve 67 is received on the servo valve piston portion 65 and is prestressed by a control sleeve spring 68, which is braced in turn on the first housing part 26 of the servo valve housing 25. The control sleeve 67 has a recess 71. The first

sealing seat 40, in the variant embodiment shown in Fig. 3, is designed as a flat seat and seals off the **second hydraulic chamber 39 from the** diversion chamber 42 (low-pressure chamber) **from and** the low-pressure-side return 28. The mode of operation of the variant embodiment shown in Fig. 3 of the fuel injector 18 with a pressure booster 3, triggered via the servo valve 24, is as follows:

Page 16, please replace paragraph [0051] with the following amended paragraph:

[0051] The first sealing seat 40 may be designed in manifold ways. Besides the embodiment of the first sealing seat 40 as a flat seat as shown in Fig. 3, it may also be embodied as a conical seat, as in the variant embodiment shown in Fig. 2, or as a ball seat. The embodiment of the first sealing seat 40 as a flat seat in conjunction with a multi-part servo valve housing 25 as shown in Fig. 3 is especially advantageous. By means of a multi-part valve body, such as the housing parts 26, 27 and ~~including~~ 66, simple manufacture of the valve seat of the first sealing seat 40 can be achieved. As a result of the flat seat shown in Fig. 3, any axial offset of the valve bodies relative to one another that may occur is compensated for. The variant embodiment shown in Fig. 3 furthermore has a strong closing pressure force, exerted by the fuel pressure, prevailing in the control chamber 36, against the first sealing seat 40, and as a result, high pressure per unit of surface area and hence excellent sealing action are established at this sealing seat.

Page 17, please replace paragraph [0052] with the following amended paragraph:

[0052] In the state of the repose of the servo valve 24, the differential pressure chamber 6 of the pressure booster 3 is subjected to system pressure via the first recesses 63 on the servo valve piston 65, and the pressure booster 3 remains in communication with the ~~differential pressure~~ source chamber because of the hydraulic communication between the second hydraulic chamber 39 and the diversion line 21. Because the pressure level in the differential pressure chamber 6 and the work chamber 5 is the same, the pressure booster 3 is deactivated. Upon triggering of the switching valve 30, a pressure relief of the control chamber 36 of the servo valve 24 is effected, causing the servo valve piston 32, 65 to open. Because of the opening force engaging the hydraulic face 44 via the first hydraulic chamber 38, an exact opening of the servo valve piston 32 is effected. Upon opening, the first sealing seat 40 is opened first, and the slide sealing edge 43 is made to coincide with the control edge 41. The control sleeve 67 is now positioned against the third housing part 66 by means of hydraulic pressure force in the second hydraulic chamber 39, and as a result, a high-pressure-proof connection is achieved. Only after that does opening of the slide seal 69 take place, when the servo valve piston portion 65 uncovers the sleeve recess 71. As a result, there is no short-circuit leakage flow from the first hydraulic chamber 38 into the return. The differential pressure chamber 6 of the pressure booster 3 now communicates with the low-pressure-side return 28, via the second hydraulic chamber 39, the slide seal 69, the first sealing seat 40, and the diversion chamber 42 (low-pressure chamber), and the pressure booster 3 is thus activated.

Applicant: Nadja EISENMENGER et al.
Docket No. R.305061-1
Preliminary Amdt.

Page 19, please add the following new paragraph after paragraph [0058].

[0059] The foregoing relates to a preferred exemplary embodiment of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Please delete pages 20, 21 and 22.